Asian Society of Agricultural Economists

8th International Conference

VIABILITY OF SMALL FARMERS IN ASIA

15-17th October 2014 Savar, Bangladesh

Organized session 5

Targeting of Grain Legumes for Income and Nutritional Security in South Asia

16th October 13.30 to 15.30

TROPICAL LEGUMES II

brac

ICRISAT
Science with a human face

Targeting and Diffusion of Chickpea improved cultivars in Andhra Pradesh state of India

K Suhasini [1], D Kumara Charyulu, I Shakuntala Devi, D Moses Shyam D and Cynthia Bantilan

ABSTRACT

Chickpea accounts for about 45% of total pulses produced in India, which is the major chickpea producing country, contributing over 75% of world production. Andhra Pradesh is the fifth largest state in chickpea cultivation. In Andhra Pradesh, Kurnool and Prakasam districts were occupying the first and second positions in chickpea production. Tropical Legumes-II (TL-II) project was supported by BMGF and has been promoting chickpea improved cultivars in the state since 2007 improving farmer's livelihood by enhancing chickpea productivity. For this Farmer Participatory Varietal Selection (FPVS) approach was followed. Further a strategic deepening and widening of technology outreach to farmers across all categories was designed by involving farmers in selection of varieties. This demonstrated the performance of improved cultivars over the check cultivars in the two targeted districts. Based on farmers' preference, cultivars were identified, multiplied and distributed to them in small seed pockets. During the first phase of the project (2007-08 to 2010-11), 476 seed pockets were distributed freely in 119 villages of two districts. A real tracking survey was taken up to track these farmers and understand their perceptions on TL-II cultivars. The main objective of the present paper is to trace adoption of chickpea cultivars, drivers of diffusion and innovations in spread of chickpea technology and examine the sustainability. In the real-time survey 487 seed and non-seed beneficiary farmers was included using probability proportionate sampling. TL-II cultivars (JG 11, KAK 2, Vihar, JAKI 9218) have completely replaced the old cultivar (Annigeri). The Logit and Tobit estimation showed that availability of household labour, access to formal seed sources, price information and literacy increased adoption of improved cultivars. Subsidized seed hastened diffusion process. Seed beneficiaries perceived 40-60% yield enhancement through improved cultivars which led to a 'Salient Chickpea Revolution' in the state.

Key words: Diffusion of chickpea improved cultivars, FPVS approach, TL-II project, Chickpea in AP.

[1]Professor in Acharya NG Ranga Agricultural University, Rajendranagar, Hyderabad

Author for correspondence hasinik2003@yahoo.co.in

Targeting and Diffusion of Chickpea improved cultivars in Andhra Pradesh state of India

Introduction

Chickpea is one of the earliest cultivated legumes has its origin during the mid of 18th century. There are two predominant chickpea types cultivated in India namely, *desi* type is small in size, light to brown seed in colour with a rough coat, cultivated mostly in the India and much of the Indian Subcontinent, as well as in Ethiopia, Mexico, and Iran and *Kabuli*, associated with Kabul in Afghanistan are lighter coloured also whitish, with larger seeds and a smoother coat, mainly grown in Southern Europe, Northern Africa, South America and Indian Subcontinent, having been introduced during the 18th century to India.

In the world major chickpea growing areas are Mediterranean, western Asia, the Indian subcontinent, Australia and the Great Plains. Major countries producing chickpeas are India, Australia, Pakistan, Turkey, Burma Ethiopia and Iran, of all, India produces almost five times more than the second largest producer of chickpea i.e; Australia and contributing over 75% of total world production. Chickpea accounts for about 45% of total pulses produced in the country.

In Andhra Pradesh, Kurnool and Prakasam were the districts occupying one and two positions in Chickpea production. During 2007-08 a baseline survey was conducted in these districts as a bench mark before any intervention. Besides this mother baby trials were introduced in 2007-08 to facilitate participatory varietal trials for selection of suitable varieties involving the farmers as a part of project Tropical Legumes II targeting Kurnool and Prakasam districts.

Before the intervention there were certain chickpea varieties cultivated by the farmers, but those existing varieties were released 30 years back and virtually yielding like local varieties because seed has lost its purity over years. Intermittently, several other varieties were tried but did not like by farmers.

The present paper attempts to give a holistic view result of TL-II intervention targeting adoption by conducting real time tracking survey. The adoption and diffusion pattern is discussed, duly mentioning about the two surveys namely baseline survey and early adoption survey conducted as a part of TL-II project before the real tracking survey, to have clear idea on the technology uptake process.

Baseline survey – lessons learnt

In Kurnool and Prakasam districts, the baseline survey was conducted to serve as a bench mark to study the impact of intervention through TL-II project at a later point of time. Proportionate random sampling technique was adopted to cover all the categories of farmers by drawing a sample of 135 from each district. Together twelve villages were surveyed. In Kurnool district Balapanur, Mitnala and Pulimaddi (3 adopted), Munagala, Rasulpet and Brahmanapally (3 control) and in Prakasam district, adopted villages were Cherukurapadu, Chirvanauppalapadu, Kollavaripalem and control villages Paidipadu, Maddiralapadu and Bodavada were selected. Both adopted (being the villages where

mother baby trials were held in 2007) and control (villages being where there was no deliberate intervention of crop improvement programme under TLII) slightly differ in project treatments, but they have similar agro-climatic conditions.

Baseline survey found that the food crops like jowar and bajra, non food crops like cotton, chillies and tobacco in Prakasam and Sunflower and jowar in Kurnool were traditional crops and these were replaced by chickpea due crop shifts. Chickpea gained prominence as it is a short duration crop, suitable to black soils, less labour intensive, suitable for mechanisation that can be taken up and also due to stable prices realised for chickpeas which lead to stable income. Baseline revealed a striking fact that the old variety Annigeri popularly referred by farmers as Gulabi was the ruling variety and was considered as a local check. The respondents of the survey were ready to buy new seed even at high price if it yields better than Annigeri.

Kumara Charyulu and Bantilan (2011) studied the tracking of Sorghum improved cultivars adoption in India and justified the role of improved cultivars in sustaining the higher yields and reducing yield variability in addition to the biotic and abiotic challenges, presumed climate change also affected sorghum area and its importance globally. The study concluded that climate change will modify length of growing period and increased the predicted temperatures across different regions. It also suggested that more thrust is needed on development of drought resistant and heat tolerant varieties using modern bio-technology tools and also emphasise on development of post-rainy season cultivars and its adoption.

Lessons learnt

- Need for replacement of existng varieties and seed replacement – with high yielding varieties and identified role of gender in chickpea
- Preferences of farmers in any new cultivar were documented and was taken as feedback to the breeders
- Great need for effective seed muliplication and seed delivery systems (formal and informal).

Therefore strategic development of new varieties considering the preferences of the farmers and other players in the market is required to be taken up to have effective crop improvement programmes. Hence the trials were held with the following desi and kabuli varieties along with local checks.

List of released/pre-released cultivars identified for each focal location for FPVS (Farmers' participatory varietal selection) after baseline survey during 2007-08

Country	States/ Divisions	No. of cultivars	Cultivars	
			Desi type	Kabuli type
India	Andhra Pradesh	8	ICCC 37, JG 11, JG 130, JAKI 9218, Annigeri (Check)	Vihar, LBeG7, JGK 2, ICCV 95334, KAK 2 (Check)

The intervention continued the trials moved away from the adopted villages and brought awareness among farmers and within a span of two years ruling variety (Annigeri) started declining and new cultivars introduced were adopted. The FPVS trials data was also analysed for documenting preferences of other farmers visiting the trials.The varieties preferred by farmers were Desi - JG 11, JAKI 9218 and JG 130 and in Kabuli – KAK 2, Vihar.

This led to the initiation of early adoption survey during 2009-10 to ascertain whether there is uptake of the chickpea technology and improved cultivars. Shah *et al.,* (2007) identified the factors accounting for low chickpea production in the year 2005-06. By conducting a survey on 40 farmers from the desert of the Oorpur Thal district Khushab in Pakistan. The results showed that almost two-thirds of the farmers have more than 20 hectares of rainfed land. Eighty-five percent of the growers used their own seed from previous crop. Lack of cleanliness in the marketing of the local landrace is one of the important factors in low productivity and less market prices. The scope for increasing production by adopting drought-resistant high-yielding varieties and improved management practices seems to contribute significantly.

All the 270 baseline survey respondents are revisited to track the early adoption in the two districts i.e., Kurnool and Prakasam. The trend in adoption was similar in all the villages surveyed, the old cultivars disappeared.

Early adoption survey – lessons learnt

The chickpea cropped area increased as a per cent of cropped area of respondents and total cropped area of the district. The varieties adopted by farmers were JG 11 and JAKI 9218 in Kurnool and JG 11 and KAK 2 in Prakasam district.

- JG 11 was adopted by 157 farmers in both districts and was sown in 1330 acres

- KAK 2 was sown by 89 farmers in 1122.5 acres and the price for KAK 2 was greater than JG 11 during this period. The yield levels are improved compared to the old Annigeri.

The adoption of new cultivars has great impact on farmers income and they realised 2.39 benefit cost ratio and where net returns ranged from Rs. 28514 to Rs. 35153 per ha. Due to the distinct performance of the new varieties later the chickpea fitted into cropping patterns in the adjacent districts as a spillover effect of the crop improvement programme under TL II.

Shiyani *et al.,* (2001) assessed the impact of improved chickpea cultivars in the state of Gujarat in India during 1970-95 based on a household survey of chickpea growers in 24 villages of four districts in Gujarat, India. The survey also revealed that improved chickpea cultivars showed distinctly superior performance over local cultivars in terms of yield, net income, and per unit cost of reduction, proving their cost and profit-maximizing characteristics. Tobit model suggested that holding size, crop duration, and yield risk significantly determined the probability, degree of adoption and found the most preferred quality traits of chickpea.

The project continued and the seed multiplication and farmer trials could outreach into new areas where there was already some demand for new seed during the years 2010-11, 2011-

12 and 2012-13.

Real time tracking survey

At this juncture the real time tracking survey was taken up to oversee the process of adoption, diffusion, technology dissemination mechanisms and innovations involved in spread of the improved cultivars introduced under TL-II looking at its sustainability.

This survey was taken up with specific objectives

1. To study adoption and diffusion process, drivers of adoption and preferences of farmers in the real time
2. Track the seed, sources, delivery process and role of various agencies in spread of the technology and to study the various seed channels including the farmer to farmer exchange

Sampling design

To take up an in depth analysis of adoption and trace the movement of seed of improved chickpea cultivars introduced in Kurnool and Prakasam districts the real time tracking survey was conducted. A sample of 487 including seed beneficiary households (2008, 2009 and 2010 and from baseline survey) and non-seed beneficiaries from baseline survey were included (Table 1).

In Andhra Pradesh, sampling details are as follows:

Table 1: List of Seed beneficiaries and sample selected

District	Total seed beneficiaries	Sample allotted included non-seed beneficiaries
Prakasam	140 (29.4)	146 (29.98)
Kurnool	336 (70.6)	341 (70.02)
Total	476 (100.0)	487 (100.00)

* 2008, 2009 and 2010 seed beneficiaries baseline farmers considered
Note: Figure in the parenthesis indicates percentage to column totals

In case of Chickpea, Andhra Pradesh, nearly 70 per cent of sample to be covered from Kurnool district in 19 mandals remaining from the 13 mandals from Prakasam district.

Mowo *et al.*, (2010) reviewed a methodology for tracking the pattern and extent of spillover of introduced technologies, using improved banana germ plasm in Lushoto a case study in Northeast Tanzania which referred to the spontaneous flow, or spread, of technologies between farmers using their social networks without external interference. The study showed that farmers made different modifications to the introduced technologies in order to fit them into the existing farming systems. The pattern of spillover is very much related to existing social networks in the community. The data on adoption parameters

input output costs seed exchange were focussed in the real tracking survey.

Barber (2000) set a pilot benchmark figures to show the true cost of irrigating (real time) an outdoor vegetable crop. The costs taken into account were ownership costs (bore, pump, pipe and irrigator) and operating costs (electricity, diesel, irrigation scheduling service, repairs and maintenance, and labour).

Accordingly, a semi structure questionnaire was designed and all the 487 farmers were interviewed to get the desired information.

Main findings of the real time tracking survey

Sample framework

The real tracking survey was conducted by contacting 330 seed beneficiary farmers and 157 non seed beneficiary farmers in Kurnool and Prakasam districts**.** The survey has widely covered 65 villages in 32 mandals. The data collected was classified and presented in two major seed and non-beneficiary categories. In Kurnool district the total seed beneficiaries are 231 and non-seed beneficiaries are 110 and similarly the seed beneficiaries in Prakasam were 99 while non-seed beneficiaries were 47 as in Table 2.

Table 2: Sample particulars of the real tracking survey, 2013 (no.)

District	Village	Treated /Control	Seed Beneficiaries		Non Seed Beneficiaries		Grand Total
			Baseline Beneficiary HH	Non Baseline Beneficiary HH	Baseline Control HH	Non-Baseline HH	
K U R N O O L	Ahalyapuram	Treated		5			5
	Alluru	Treated		4			4
	Amadagunta	Treated		10			10
	Amadala	Treated		3			3
	Anupuru	Treated		5			5
	Appalapuram	Treated		5			5
	B.Kotukur	Treated		8			8
	Balapanuru	Treated	5			25	30
	Banganipally	Treated		1			1
	Beemuni Padu	Treated		3			3
	Bramhanapalli*	Treated			10		10
	Chamgondla	Treated		4			4
	Govindapalli	Treated		5			5
	Gudipadu	Treated		3			3
	Guduru	Treated		9			9
	Gulamnabipeta	Treated		5			5
	Guttapadu	Treated		3			3

	H.Kottala	Treated		3			3
	Hussaina Puram	Treated		13			13
	K.Nagulapura	Treated		9			9
	Kalluru	Treated		10			10
	Kalugotha	Treated		9			9
	Kasipuram	Treated		6			6
	Kolvmuapalli	Treated		4			4
	Loddipalli	Treated		6			6
	Maddikera	Treated		3			3
	Mandyala	Treated	1				1
	Mitnala	Treated	1			29	30
	Munagala*	Treated			13		13
	Parla	Treated		5			5
	Peddakottla	Treated		6			6
	Pedda marriveedu	Treated		2			2
	Peddamudium	Treated		7			7
	Penchikalapau	Treated		11			11
	Polakollu	Treated		5			5
	Poluru	Treated		3			3
	Pulimaddi	Treated	7			23	30
	R.Kanyapuram	Treated		3			3
	R.Lingamdinne	Treated		6			6
	Rasulpet *	Control			10		10
	Revanuru	Treated		11			11
	Salkapuram	Treated		18			18
	Tangutur	Treated		4			4
	Total Kurnool		**14**	**217**	**33**	**77**	**341**
P R A K A S A M	Anumpalle	Treated		5			5
	Bodavada*	Control			5		5
	Chandulur	Treated		9			9
	Cherukurapadu	Treated				10	10
	Chervanuppalapadu	Treated				9	9
	Chintalagunta	Treated		12			12
	Dyralararuru	Treated		6			6
	Giddalur	Treated		9			9
	J.Pangulur	Treated		2			2
	Janakavarm	Treated		6			6

	Kalagatla	Treated		8			8
	Kollavaripalem	Treated				10	10
	Kongapadu	Treated		17			17
	Kurravanipalem	Treated		4			4
	M.Nidamanury	Treated		8			8
	Maddirala Padu*	Control			7	1	8
	N.Aaraharam	Treated		5			5
	Pedarukatla	Treated		8			8
	Paidipadu*	Control			5		5
	Total Prakasam			**99**	**17**	**30**	**146**
	Grand Total		14	316	50	107	487

- Treated villages of Baseline survey

* - Control villages of baseline survey

The mixed profile of the of sample farmers is presented in Table 3 showing education, caste category, experience in Chickpea cultivation etc for seed beneficiaries and non-seed beneficiaries.

Among the 330 seed and 158 non seed beneficiaries, seed beneficiaries are found to be more educated than non-seed beneficiaries with their mean schooling years being 8.40 years compared 6.96 years. Among the sample 17 members were SCs, 156 are BCs and 303 are OCs, with a coverage of SC beneficiaries is low just 3% but the BC farmers covered were accounting to 32% of the sample. The average experience of chickpea cultivation by seed and non-seed beneficiary farmers is almost the same i.e., 10.98 and 10.25 years confirming that chickpea as crop started only a decade ago.

The extent of own land holding was 14.1 acres in case the entire sample and the mean operational holding was 16 acres corroborates that leasing in land and development in land markets.

It was noteworthy that 98.76% of the sample farmers cultivated chickpea in deep black soils reinforcing the soil suitability for adoption. So diffusion took place in adjacent areas with black soils.

Shiyani *et al.*, (2001) aimed to track adoption of improved chickpea varieties, and assess their on-farm benefits in some remote and backward tribal villages in Gujarat, India, where few newly developed varieties were introduced by a non-government organization. It also determined key factors which were influencing their adoption and found that adoption of improved chickpea varieties was gradually increasing by replacing a prominent local variety. Duration of crop maturity, Suitability of soil, yield risk, and farmers' experience of growing chickpea significantly influenced the adoption.

Area expansion under chickpea

Total area cultivated by sample farmers is 8148 acres in 2013, while it was 4890 acres in 2012-13, showing doubling of the area establishes the tremendous potential for chickpea. Almost 78% of the farmers were stable and want to maintain the same area under chickpea while 13% farmers were decreasing area under chickpea cultivation. Few members, about 22 want to expand the area under chickpea. The decline in area is because prices are being stagnant even after waiting for six to seven months after harvest using the storage facilities. The competitive crops were tobacco and jowar.

As new areas are already gaining (Medak and Guntur) definitely there is scope for increase in the area but depends on market and import export policies.

Table 3: Characteristics of sample farmers

Item	Seed beneficiaries (N=330)	Non Seed beneficiaries (N=157)	Sample Average/ Sample Total (N=487)
Education *(years of schooling completed)*	8.40	6.96	7.94
Caste Category (No.)*			
SC	15	2	17
BC	120	36	156
OC	185	118	303
No. of years of experience in Chickpea cultivation (years)	10.98	10.25	10.74
Extent of own land *(including rain fed and fallow in acres)*	14.10	14.19	14.13
Extent of operational land (in acres)	16.31	17.62	16.73
Chickpea growing plot soil type			
Deep black (No.):	324	157	481
Light black:	6	-	6
Red soil:	-	-	-
Others etc:	-	-	-
Total area (Acres):	5381.5	2766.5	8148
Area under Chickpea cultivation in 2012 -13 *(in acres)*	3346	1544.5	4890.5
Allocation of area under Chickpea cultivation during last three years (No.)			
Increasing:	22	13	35
Decreasing:	49	19	68
Same:	259	125	384
Did you irrigate your Chickpea field (No.)			
Yes:	12	5	17
No:	318	152	470
Distance to regulated market *(km)*	16.30	12.28	15.01
Distance to Research station *(km)*	21.49	12.28	15.01
Distance to Agricultural Office *(km)*	10.07	9.25	9.80

Distance to Storage facility *(km)*	12.75	12.46	12.66
Are you member of any organization/society (No.) **			
Yes:	19	9	28
No:	309	148	457

*11 respondents have not disclosed their caste, **2 HH not responded

The average distance from the seed beneficiary villages to the regulated markets is more 16.3 km and to the Research stations is 21 km when compared to 12.28 km for the non-seed beneficiaries households to the regulated markets and research stations. This reconfirms the effective implementation of the crop improvement programme by TL-II making the improved seed available at far away locations.

Storage facilities like warehouses/cold storage units were in a vicinity of 12 km for all the villages included in the survey a major achievement in the targeted area by mobilising private investment into agriculture.

Seed distribution and implementation

TL II project seed beneficiaries for the past 4 years studied are presented in Table 4, which shows the variety wise seed distributed for the trials of seed beneficiaries from 2008-09 to 2011-12. The seed beneficiaries covered were about 150 during 2008-09, 76 members received JG 11, 45 members got JAKI 9218 seed, 27 members JG 130 seed and 22 members were given with KAK 2 and Vihar seeds. During 2009-10, there were about 127 seed beneficiaries, 52 farmers supplied with JAKI 9218, 23 farmers covered under JG 11 and 22 farmers with JG 130 seed. The trials were taken up in an aggressive way with wide and deep coverage. Besides comprehensive chickpea crop technology is given. Once the farmer is aware of the yield potential of new varieties he would be ready to try the new seed in his field, if seed is available. Therefore, only 20 kg of seed pockets were given to each farmer and thus bringing many farmers into the purview of seed distribution programme/trials. Slowly the withdrawal of the intervention started, thereby creating necessity to farmers to meet the seed demand. This has resulted in development of public and private and farmer to farmer seed networks creating a platform for the exchange of quality seed.

The average quantity of new cultivars seed given for trials and seed multiplication ranged from 17.5 to 25 kg. The judicious use of seed produced by distributing it to many farmers has helped the farmers either their use own seed or exchange seed. This has triggered the demand for quality seed, when there is such a demand for seed of the improved cultivars, even the public channels also responded. Thus, the adoption of the new cultivars hastened.

Implementation of trials

Success rate in sowing the seeds of new cultivars was 95% and just 5% farmers who could not plant the seed.

Table 4: TL-II seed beneficiary details (seed beneficiaries only N =330)

Details	2008-09	2009-10	2010-11	2011-12
HH TL-II project seed beneficiary (no.)	No.	No	No	No
Which Variety seed provided				
JAKI 9218	45	52	11	2
JG 11	76	23	9	-
JG 130	27	22	1	1
KAK 2	10	17	4	-
Vihar	12	13	4	3
Avg. quantity of seed provided (kg)				
Variety	2008-09	2009-10	2010-11	2011-12
JAKI 9218	20.34	19.23	22.27	17.5
JG 11	20.01	18.04	18.33	-
JG 130	18.96	21.36	25	25
KAK 2	19	20.88	21.25	-
Vihar	18.75	21.15	18.75	18.33
Did the household sown this variety (no.) Y: N:	 156 11	 121 6	 28 1	 5 1

Along with seed networks, to restore the germination of seed, scientific seed storage in warehouses and cold storage units also has started. The middle men of the commission agents also were helping the farmers to store their seed and try for loans on the basis of warehouse receipt. Thus the number of warehouses has tremendously increased. Storage also is used to mitigate the price risk.

Seed benefitted year – Area sown by seed beneficiaries

As seen from Table 5, the year before the seed benefitted year 223 acres were cultivated under Annigeri variety during 2006-07 though there was slight awareness of initiation of mother baby trials. But during the seed benefitted year the variety Annigeri disappeared among seed befitted farmers, as it was proven to be a low yielder and there was a latent demand for a new variety.

Table 5: Adoption of improved cultivars (sum of area in acres)

	Seed beneficiary		Non seed beneficiary	
Variety	Previous year of benefitted year	Seed benefitted year	Previous year of benefitted year	Seed benefitted year
Annigeri	223		59	
JAKI 9218	33	624	7	100
JG 11	111	969.25	47	523.5
JG 130	14	367.5	5	33
KAK 2	34	167	4	
Vihar	14	291	6	16
Total Area	445	2444.75	129	688.5

The area under all the new cultivars of chick pea has increased to 2444 acres in the fields of seed beneficiaries and 688.5 acres in the non-seed beneficiaries fields.

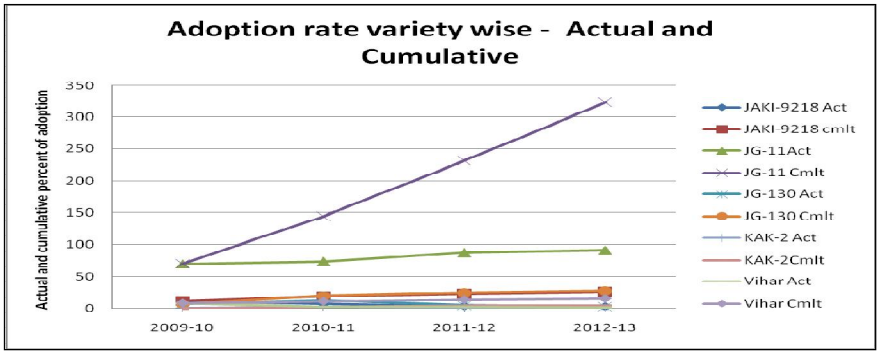
Seed Sources

All the varieties were primarily obtained from PVS trials only (75% farmers) and about 20% of the farmers obtained seed from farmer to farmer exchange, which the second best source of seed. This confirms the strength of informal exchange of seed from farmer to farmer. The third important source of seed on which 11% of farmers depended is the Govt. seed supply.

Varietal adoption and diffusion - 2008-09 onwards

The varietal adoption and diffusion from 2008-09 to 2012-13 was presented in terms of actual and cumulative percentage to total area sown by beneficiaries is presented below which showed that the actual and cumulative adoption rate of JG 11 in 2009-10 is 69.85 which gradually increased to 91.73 in terms of actual percentage and 323.06 as cumulative percentage. In case of JAKI 9218 the actual percent adoption decreased from 2009-10 to 2012-2013 i.e., from 12.17 to 2.88 whereas the cumulative per cent adoption increased from 12.17 in 2009-10 to 26.07 in 2012-13.

Figure 1: Variety wise adoption rate

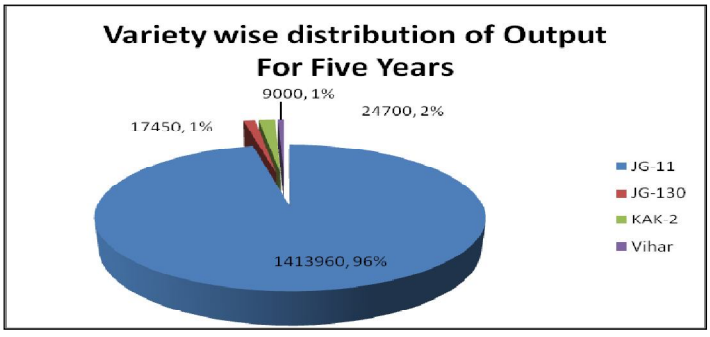


While for other varieties it is not so convincing as shown in Figure 1.

Production – variety wise seed beneficiaries

The total output recorded by seed beneficiaries as an aggregate of the five years variety wise is depicted in Figure 2 which showed JG 11 was occupying 96% of the output produced.

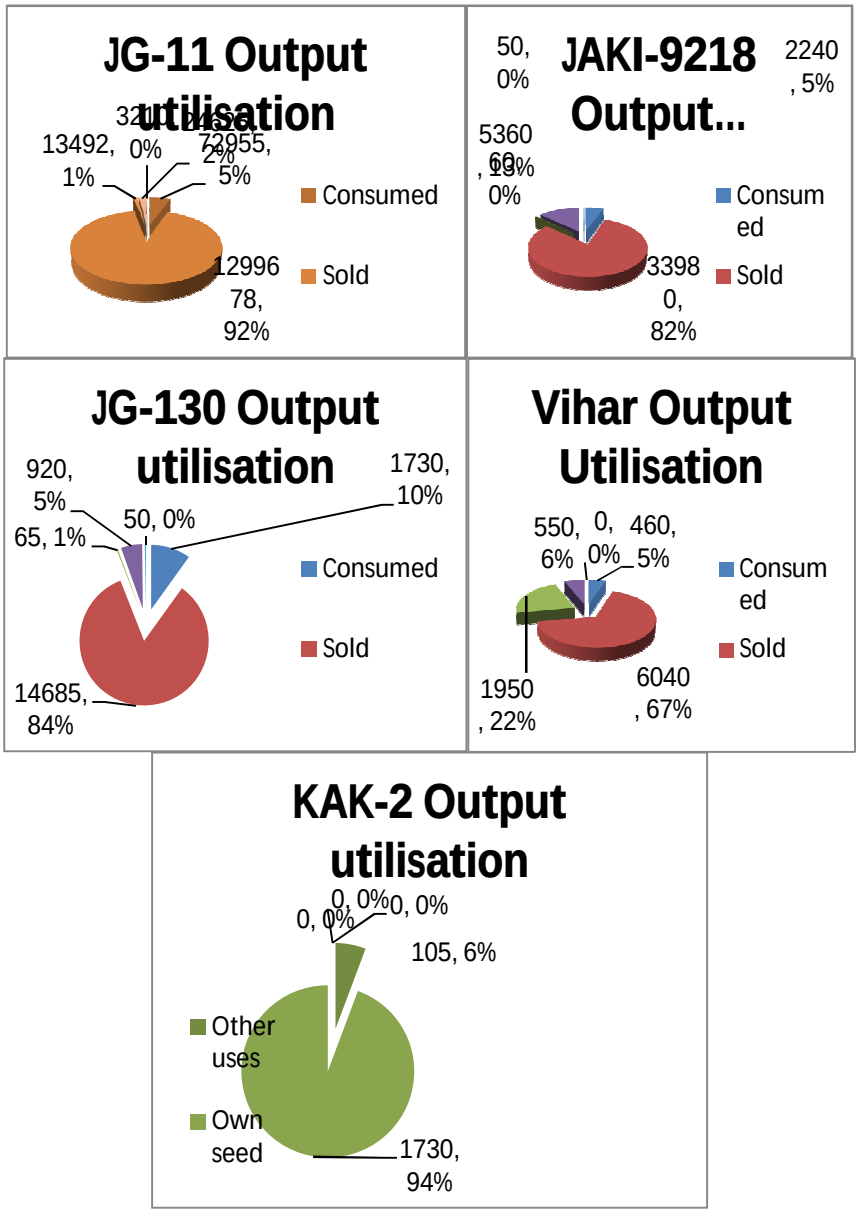
Figure 2: Variety wise output- seed beneficiaries



Output utilisation – Seed beneficiaries variety wise

The farmers were unable to quantify exact quantity of seed exchanged with other farmers, but it was noted that majority of seed also gets exchanged from the storage ware houses. Variety wise output utilisation pattern was depicted in the following Figures 3 to 7. When the output sold was observed variety wise the sold quantity ranged from 67% to 96% of the output. Consumption was around 5% of the output which was definitely used by farmers for day to day consumption; it serves as rich source of protein taking care of nutritional security of the targeted population.

Figures 3, 4, 5, 6 and 7: Variety-wise output utilisation pattern



Costs and return from chickpea cultivation

A year before the seed benefitted year there were about 225 farmers growing Annigeri in 1952.5 acres. Costs and returns obtained from new cultivars JAKI 9218, JG 11, JG 130, KAK 2 and Vihar and Annigeri the old cultivar pertaining to 2012-13 is presented in Table 6.

Table 6: Costs and returns from new cultivars and Annigeri, 2012-13

Operation	Cost of Cultivation`/acre						
	Annigeri	JG 11	JAKI 9218	JG 130	KAK 2	Vihar	Pooled average
No. of farmers	225	382	51	24	13	17	118
Sum of area	1952.5	3145.5	176	152	26	122	929
Land preparation	1093.75	1904.85	2005.55	1956.94	2269.23	2307.27	1922.9
FYM/Compost	0.00	479.51	804.90	450.27	0	194.54	321.5
Seed costs	1000	1863.68	1838.56	1750	2123.07	2072.72	1941.3
Sowing costs	718.75	1145.39	1121.07	997.22	839.56	892.72	952.5
Fertilizer costs	855.62	2339.27	2470.40	2093.61	3092.30	2666.66	2253.0
Micro-nutrient costs	-	9.94	29.41	-	-	-	6.6
Inter-culture costs	93.75	253.97	543.30	539.58	-	31.81	243.7
Weeding costs	406.25	725.31	792.35	727.77	1350	890.90	815.4
Plant protection costs	1250	1828.30	1711.20	1591.59	2619.23	2127.27	1854.6
Watching expenses	56.25	16.75	54.90	3.75	-	-	21.9
Harvesting costs	962.5	1003.28	1120.42	1096.73	1003.84	1141.66	1054.7
Threshing costs	687.5	799.35	899.90	878.12	1830.76	1138.18	1039.0
Marketing costs	82.5	222.67	237.67	213.64	147.69	213.43	186.3
Rental value of land	6000	6115.84	6345.96	6895.83	6192.30	6772.72	6387.1
Others costs if any	-	-	127.45	-	-	-	21.2
Total costs	13206.87	18752.67	20103.11	19195.09	21468.02	20450.70	19029.4
Grain-pod yield (kg)	425	762.66	641.17	695.83	670.83	700	632.6
% increase in grain yield over Annigeri	0	79.44	50.86	63.72	57.84	64.70	48.84
Grain-pod price/kg	34	36.66	33.71	33.25	39.08	38.45	35.9
Gross returns	14450	27959.12	21613.84	23136.35	26216.04	26915	22710.34
BCR	1.09	1.49	1.07	1.20	1.22	1.31	1.19

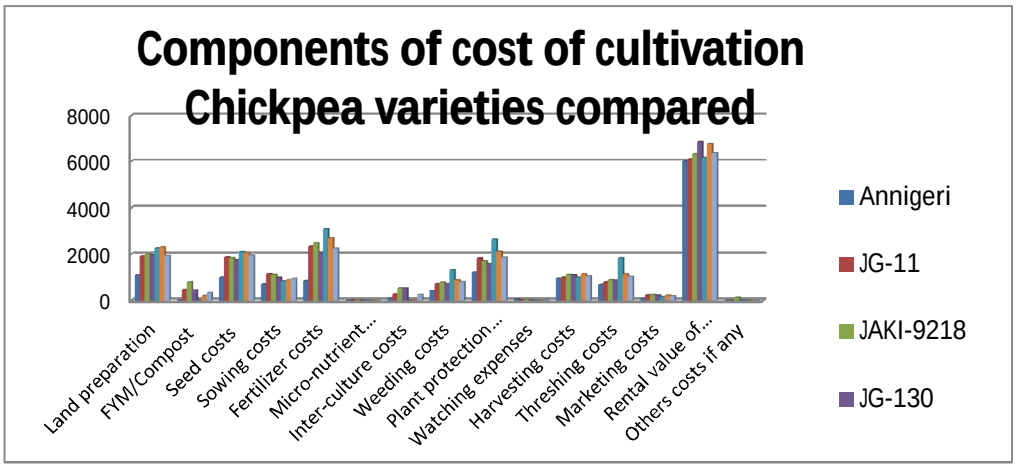
The farmers growing JG 11 are 382 in number planted chickpea in an area of 3145.5 acres, farmers growing JAKI 9218 are 51 in an area of 176 acres. Number of farmers growing JG-130, Vihar and KAK 2 are 24, 17, 13 and acreages are 152, 122 and 26 under each cultivar respectively. The cost of cultivation shows the expenses incurred in each operation for each cultivar.

JG 11 is the most preferred variety among farmers the expenses incurred per acre towards various farm operations are land preparation, FYM/Compost cost, seed cost, sowing cost and fertilizer costs which are 1904.85, 479.51, 1863.68, 1145.39 and 2339.27. Expenditure towards inter cultivation is 253.97, cost for weeding is 725.31, expenses towards plant protection chemicals is 1828.30. The average rental value paid per acre of land is 6115.84.

The cost of cultivation for JAKI 9218 was 20103/acre of which rental value of land is 6345 and fertiliser cost is 2470 per acre. Seed cost was highest for KAK-2 which is 2123/acre followed by Vihar 2072 among the desi varieties JG 11 seed cost was highest 1863 per acre.

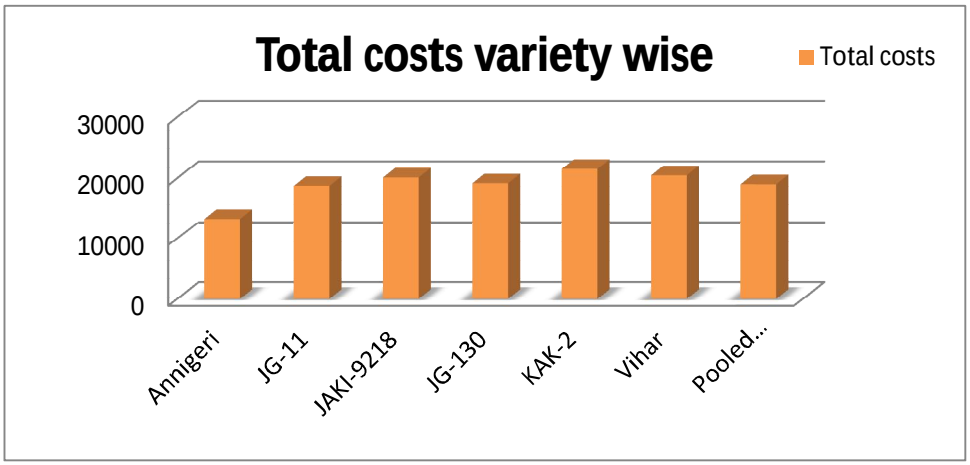
The benefit cost ratio was highest 1.49 for JG 11 clearly endorsing the potential yield and preference by the market and farmers for its higher yields of about 762.66 kg per acre on an average.

Figure 8: Cost components variety wise



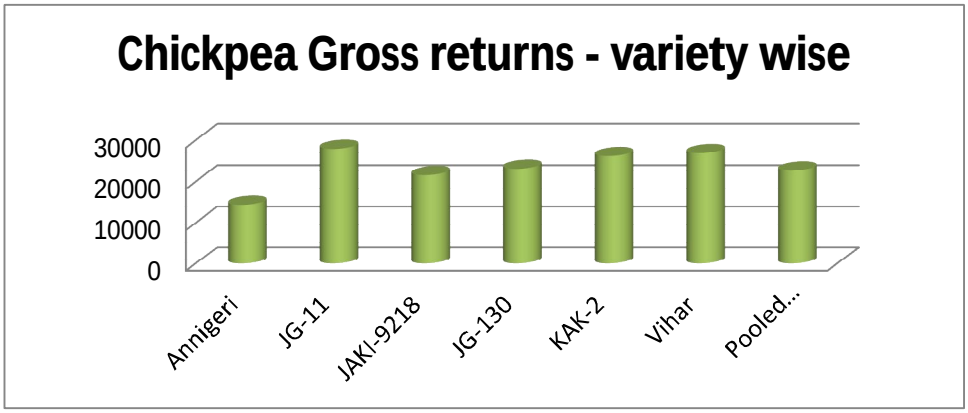
Cost components variety wise are compared in the above figure for all the varieties. Major expenditure in chickpea cultivation is for land preparation, seed cost fertiliser cost and plant protection, but nevertheless the rental value of land is highest among all the cost components.

Figure 9: Cost of cultivation by variety-wise



Variety wise cost of cultivation was more for Kabuli varieties than desi varieties. KAK 2 and Vihar recorded a cost of cultivation of 21468 and 20450 per acre as shown in Figure 9.

Figure 10: Gross returns by variety-wise



Gross returns for the varieties were highest for JG 11, Vihar followed by KAK 2 as depicted in the above figure.

Seed exchange

The quantity of JG 11 shared is 21332 kg between 71 farmers in the seed benefited village and 50 farmers were benefited in other village. 5210 kg of JG 130 is shared by 11 farmers in the same village and 26 other village farmers. 2500 kg of KAK 2 is shared by 3 farmers in the same village and 11 other village farmers. The amount of JAKI 9218 variety shared among 4 farmers of same village and 2 farmers in other village is 2400 kg. One farmer is benefited by Vihar by getting 300 kg seed, he belongs to same village. A total of 31792 kg of chickpea is shared and 112 same village farmers and 99 other village farmers were benefited by this.

Table 7: Seed sharing with other farmers

During the last three years, did you share seeds with any one (No.)?		Yes: 35	
		No: 452	
		Total no. of farmers benefitted	
If yes, what are the varieties?	**Total quantity shared (Kg)**	**SV(No.)**	**OV(No.)**
JAKI-9218	2400	26	10
JG-11	21332	71	50
JG-130	5210	11	26
KAK-2	2500	3	11
NBG-1	50	-	2
Vihar	300	1	-
Grand Total	31792	112	99

Role of institutions in Adoption Process

Role of institutions and their interventions in the targeted area, there where institutes like NSC, A.P. Seed, Department of Agriculture, Agri-biotech foundation, Kurnool seeds and Murali seeds played an important role in seed distribution. The National Seed Corporation distributes JG-11 seed, and High Yielding varieties were distributed by A.P. Seeds.

Department of Agriculture distributes seed on subsidy. Vihar is distributed by Agri-biotech foundation.

Drivers of technology adoption and diffusion

In this study Logit model was employed to examine the incidence of improved chickpea

adoption respectively. The binary Logit model is specified as follows:

$$Y_i = \beta_i X_i + \mu_i \quad \ldots (1)$$

Y_i = 1; if farmer grows improved chickpea varieties;

Y_i = 0; Otherwise

Whereby:

Y = Adoption of improved chickpea varieties

β = Parameters to be estimated

X =Vector of explanatory variables

E_i and μ_i= Random errors.

Therefore to model the adoption of improved chickpea varieties, the following equations were specified:

Logit Model

ADOPCH= NOWFM + TFM+ TOPHL+OTCROP+ GHINCOME+ DITRICT+

FARMSIZE + SECOCCPD+SEEDSOUR +IRRLAND+ NOLITM+SORINFO

In a standard regression model, the dependent variable is generally assumed to take on any value within the set of real numbers and the probability of any particular value is zero. In the dichotomous Logit model, the dependent variable assumes only two values, i.e. 0 and 1, each of which is assigned a probability mass.

Description of variables used in the Logit Model and their expected sign

Dependent variable	
PORPLCH	Proportion of land allocated for improved chickpea
ADOPCH	Improved chickpea adoption 1= adopter 0=otherwise
Explanatory variables	
NOWFM	Number of working family members
TFM	Total family members
CDINDEX	Crop diversification index
NOLITM	Number of literate family members
TOPHL	Total operational landholding (acres)
ATPINF	Access to price information 1=yes 0=no
GHINCOME	Gross household income in thousands (Rupees)
DISTRICT Dummy	District 0=targeted 1=Any other
MARKBEH	Marketing behavior 1=sell immediately after harvest 0=no
NFARMSIZE	Nature of farm size 0=marginal 1=small 2=medium 3=large
SECOCCPD Dummy	Secondary occupation 1=yes 0=no
IRRLAND	Irrigated land in acres
SORINFO	Sources of information 1= combined sources 0=single sources
SEEDSOUR Dummy	Seed source 1=formal 0=informal
VILLAGE	Village type 0=seed benefitted village 1=not benefitted

Table 8: Logit model estimates for household adopted improved chickpea varieties

Adoption of improved chickpea varieties	**Parameter estimate β**	**S. E**
No of working family member s	0.965***	0.292
Total family members	-0.661***	0.211
Total operational land (acres)	0.127	0.137
Gross household income (thousands)	0.014*	0.009
District (dummy)	-0.879*	0.547
Farm size distribution	1.061**	0.541
Secondary occupation (dummy)	-0.674	0.579
Seed sources (dummy)	2.665***	0.901
Irrigated land (acres)	-0.148	0.164
Number of literate family number	0.279	0.252
Source of information	0.682**	0.276
_constant	-0.603	1.003

***=Significant at p<1%; ** = Significant at p <5%; * = Significant at p<10%;

The Logit model was used to investigate factors affecting the adoption of improved chickpea varieties as shown in Table 8. The model is significant at 1% level. The adoption of improved chickpea varieties was increased by 162.5 per cent for a unit increase in working family members. Productive labour is more important than no of men in family in adoption of chickpea varieties. The result also shows gross household income marginally increase adoption of improved chickpea. For a thousand rupees increase in household income the adoption increases by 1.4 per cent. The result implies that the likelihood of adoption was found to be considerably high with the presence of reliable and formal seed source.

Access to diversified information sources increases adoption of improved chickpea adoption by 98 percent. The more information pathways the farmer has, the more the farmer intensifies adoption of technologies. Indeed, studies of innovation adoption and diffusion have long recognized information as a key variable, and its availability is typically found to correlate with adoption (de Harrera and Sain, 1999). Information becomes especially important as the degree of complexity of the technology increases and when the farmers are trial and decision conformation stage (Nowak, 1987). Information sources that positively influence the adoption of technologies can include: other farmers; media; meetings and extension officers.

Although not statistically significant, a unit increase in operational landholding and number of literate household member increase the adoption of improved chickpea varieties by 12 and 32 per cent respectively while an increase in acre of irrigated land in decrease the adoption by 14 per cent that farmer may go for irrigated crops.

The Logit estimation shows that availability of household labour, access to formal seed sources, diversified and reliable information sources, price information and number of literate household member increases the likelihood of adoption. It is therefore important that appropriate seed delivery mechanism should be put in place after an introduction of improved seed for verification. Designing appropriate communication strategy which encompasses traditional communication media is indispensable to hasten adoption of improved chickpea varieties as the majority of farmers' access information from their social network. Providing timely and reliable price information also encourages adoption of chickpea and should get the attention of policy makers to encourage market intelligence networks.

Literature Cited

De Harrera, A.P. & Sain, G. (1999). Adoption of maize conservation tillage in Azuero, Panama. Economics. Working Paper 99-01. CIMMYT.

Kumara Charyulu D. and Bantilan M.C.S 2011 Tracking of Sorghum Improved Cultivars Adoption in India 7th ASAE Conference, Hanoi, Vietnam

Mowo, J. G. German, L. A. Kingamkono, M. N. Masuki, K. F. 2010. Tracking the spillover of introduced technologies: the case of improved banana (Musa spp.) germplasm in northeast Tanzania. Acta Horticulturae; (879): pp.695-704.

Nowak, J (1987).The Adoption of Agricultural Conservation Technologies: Economics and Diffusion Explanations. *Rural Sociology* 52:208-220.

Shah, N. A. Aujla, K. M. Mazher Abbas Khalid Mahmood. 2007. Economics of chickpea production in the Thal desert of Pakistan. Pakistan Journal of Life and Social Sciences. 5: (1/2). pp 6-10

Shiyani, R. L. Joshi, P. K. Asokan, M. Bantilan, M. C. S. 2002. Adoption of improved chickpea varieties: KRIBHCO experience in tribal region of Gujarat, India. Agricultural Economics. 27: (1) pp.33-39

Shiyani, R. L. Joshi, P. K. Bantilan, M. C. S. 2001 Impact of chickpea research in Gujarat. pp.36